

## Defining Drought in Montana

### MEETING MINUTES

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The Monitoring Sub-Committee (MSC) of the Governors Drought and Water Supply Advisory Committee (DWSAC) met on January 17, 2017 from 10am – 3pm to discuss how to define drought in Montana. The MSC is made up of experts from the National Weather Service (NWS), United States Geological Society (USGS), the Natural Resources and Conservation Service (NRCS), the Farm Service Agency (FSA), the National Agricultural Statistics Service (NASS), the Bureau of Reclamation (BOR), the Montana Bureau of Mines and Geology (MBMG), the Montana State Library, the Montana Climate Office, and the Department of Natural Resources and Conservation (DNRC). The meeting was held from 10am to 3pm and involved a presentation from a firm hired by the City of Bozeman, AE2S, to create a drought monitoring model for its municipal drought management plan, the first of its kind in the state. The remainder of the time was spent on a series of facilitated discussions on various topics related to defining drought in the geographically complex and climatically diverse state of Montana.

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#### 1. AE2S Presentation

Scott Buecker and Jacob Barney

A handy slide show and handout were presented to help the MSC understand how a model to monitor drought conditions in Bozeman was created.

Jacob, who works in North Dakota, explained that he developed similar models for Grand Forks and Fargo, and that these set the precedent for the approach used in Bozeman.

Their first step was to work with the City to determine how many stages of drought would be contemplated and then determine quantitatively how to make a judgement on when to transition from one to the next. The City came up with a 4-stage approach as a way to balance the need to set stages of drought, but also to avoid the potential for public outreach fatigue on the subject. Jacob indicated 4 stages does leads to a bit more of an abrupt change between different stages.

The second step was to establish a water-supply focused approach to measuring drought severity based on the City of Bozeman's vulnerability to surface water depletions – be it from population growth or changes in the hydrologic cycle or both. Part of the reason for a water-supply focused approach is because the City of Bozeman's drought response is to quantifiably reduce water consumption to ensure a reserve available in times of drought. Each stage of drought is correlated to a water reduction goal implemented through the City's municipal code.

The third step was to decide on a key set of indicators. The method for determining which indicators would be used involved evaluating the period of record, the number of data inputs, the applicability to the water supply sources, the ability to explain anomalies, and whether the information was naturalized or subject to human influence. In the end, the model is made up of three national indices (PDSI, SPI, and USDM), two SNOTEL sites, two USGS stream gages, storage reservoir data, and a groundwater well. Once these inputs were decided on, AE2S worked with the City to establish a functional way to weight each factor so that the outcome seemed reasonable to decision makers. The weighting and calibration of the model continues to be tinkered with and that will likely continue for some time until there is consensus that its outputs contain zero error.

Finally, AE2S linked the data to the stages of drought based on historical exceedance probabilities, which needed to be adapted and revised several times. The question came up of whether the stages are to be indicators of drought on the horizon (proactive) or an indication of drought in the immediate future (reactive). The decision was to set the stages of drought in such a way so that it is not too late to do mitigation efforts and create a "piggy bank" of water for essential needs.

The model will be used monthly, or if in drought weekly. The weighting factors change seasonally. The information is pulled from various sources and stored on a website where city staff can copy and paste it into a spread sheet that calculates an overall "Composite Drought Stage" number.

## 2. Indicators of Drought in Montana

- What are the indicators of drought in Montana?
- Where are which indicators most relevant?
- Which drought indicators best account for the types of drought – hydrologic, meteorologic, agricultural, socioeconomic?

In discussing the indicators of drought the group discussion built a list of the water use sectors (fish, wildlife, agriculture, livestock, municipal/domestic, industrial, power, mining) and the potential indicators each one would look to for signs of drought. The decision at the end of the discussion was to harmonize that list by seeing which indicators were common to all water use sectors. Even given that there are terrestrial, hydrologic, meteorologic and socioeconomic types of drought, the following list of indicators appears to be the most relevant each water use sector without over-complicating the effort of predicting drought conditions:

### Montana Indicators of Drought Across Water Use Sectors

1. Stream flow data
2. Water Quality data (temperature, DO, turbidity, toxins)
3. Reservoirs

4. Water right calls
5. Temperature
6. Precipitation
7. Snowpack
8. Evapotranspiration
9. Groundwater
10. Weather forecast
11. Climate prediction

#### Data points

#### Models

- Gridded – topographically resolved
- Predictive
- Remotely sensed/satellite

#### Divide Montana?

- By watershed – what HUC order?
- By county
- What is useful to consumers of the info?
- How to meet the needs of all water users to understand drought conditions?
- Let the partitioning be part of the application of the drought management plan.
- 8<sup>th</sup> Order HUC
  - o VegDRI
  - o Drought Severity Index
  - o MOD16
  - o Antecedent conditions
  - o Precipitation and temperature

#### Time Scales

- 12 month SPI
- Monthly percent of normal precip/temp (accounts for 30 year normals)
- From start of current Water Year
- Previous Water Year to current

#### 3. What do we have and what do we need?

- Does the state need to be divided up into different parts? If so, how and based on what criteria?

- Are their certain indicators common to the entire state that allow for a defensible definition of drought stages?
- What metrics are missing and how to get them?

In discussing whether Montana should be divided, the group discussion concluded that the 8<sup>th</sup> Order HUC level would be the ideal level at which to make data available. This level of refinement would provide local producers, watershed managers, and communities with the most relevant information for their various decision making needs. It was also noted that part of reporting on drought conditions on a monthly timeline for the entire state requires an ability to gather a lot of information in a small amount of time. It was also agreed that in terms of communication and response it may be best to keep a county delineation as part of the state's assessment and reporting on conditions. This approach would continue to allow the agencies represented on the Governor's Drought and Water Supply Advisory Committee appropriate avenues of communication with local constituents (DES and DES Coordinators, FWP and FWP Fisheries Biologists, DNRC and DNRC Regional Offices, Watershed Groups and Conservation Districts, Governor's Office and County/City Commissioners, DEQ and County Sanitarians, Dept. of Agriculture and Dept. of Livestock with NRCS, FSA and Extension offices). The MSC also voiced an interest in letting any partitioning of the state be part of the application of the drought management plan.

Given the multiple levels at which consumers of drought-related information need to obtain information, it was agreed that an ideal tool would be able to zoom in and out and provide more focused data at different layers of refinement, similar to the Montana Cadastral. In lieu of such a tool, the group agreed a list of relevant drought indices that would be consistently used on a monthly basis would offer a starting point for defining drought for the state. The group began with the following list of available indicator tools:

#### Drought Indicator Tools

- SPI/SPEI
- SNOTEL
- Snowcourse
- Mesonet
- NOAA/RAWS
  - o Precipitation
  - o Temperature
  - o Forecasts
  - o Weather stations
- US DM
- USGS stream gages
- SWAMP

- Groundwater wells
- Reservoir data from BOR and DNRC
- VegDRI
- Grace data
- PRISM
- SWSI
- PDSI
- WRCC models
- HPRCC models
- DEQ water quality
- MOD 16
- MODIS (ET)
- Drought Severity Index (DSI)
- NASA Remotely sensed fire indices
- Solar radiation
- Paleoclimatology
- Potential ET minus actual

A discussion ensued during the compilation of the above list analyzed the difference in value between point data versus modeled data. The MSC determined that a combination of gridded and point data should be used. In addition, appropriate time scales need to be taken into account. The discussion concluded that the following time scales would be appropriate in assessing whether drought was occurring: the one month and 12 month SPI, monthly percent of normal precipitation and temperature (which accounts for 30 year normals), from the start of the Water Year, and from the previous water year to the current date.

#### Time Scale Analysis

1. One and 12 Month SPI
2. Monthly percent of normal precipitation and temperature
3. From start of the Water Year percent of normal precipitation and temperature
4. From the previous Water Year to current percent of normal precipitation and temperature

The MSC began a conversation about what data would be relevant at the 8<sup>th</sup> Order HUC level of refinement. A half-list was created to begin this discussion that can be further developed in the future.

#### DRAFT 8<sup>th</sup> Order HUC Level Data

1. VegDRI
2. Drought Severity Index
3. MOD16
4. Antecedent conditions
5. Precipitation and temperature

The MSC concluded that the following data should likely go into the assessment of drought conditions for Montana. Still needed is a numeric rating system to identify at what point do each of the following products indicate what level of drought.

Key Drought Indicators for Montana

<b>Precipitation products</b>	<ul style="list-style-type: none"><li>- Point – NOAA NWS, NRCS SNOTEL, RAWS</li><li>- Gridded- NOAA, HPRC/WRC, Gridded (PRISM and Daymet)</li><li>- Snowpack – Snowcourse, SNOTEL</li></ul>
<b>Temperature Products</b>	<ul style="list-style-type: none"><li>- Point – NOAA NWS, NRCS, RAWS</li><li>- Gridded – NOAA, HPRC/WRC, Gridded (Prism and TopoWx)</li></ul>
<b>Water Supply</b>	<ul style="list-style-type: none"><li>- USGS</li><li>- SWAMP</li><li>- Reservoirs</li></ul>
<b>Derived Drought Products</b>	<ul style="list-style-type: none"><li>- PDSI</li><li>- SPI</li><li>- SPEI</li><li>- EDDI</li><li>- VegDRI</li><li>- DSI</li><li>- Aridity Index (good proxy for soil moisture)</li></ul>

The MSC determined the following items are still needed:

- Finer resolution drought conditions
- ET data
- Current moisture conditions bounced against precip and temp
- Base flow index going into the winter for each of NRCS 53 rivers
- A vulnerability assessment
- A numeric quantification metric to define coming in and going out of drought

4. Exploring a Montana Drought Stage Estimation Model

- Is this a model worth pursuing at the state level?
- What resources do we have in-house to aid in putting one together?
- Is there funding available to explore the concept further?
- How will it change the way the drought assessment process currently works?

The MSC did not have a concrete response to the above questions. The general feeling was a state-wide model would be much more difficult to achieve than making one for a discrete locality. It will likely be of benefit to see the outcome of the state's vulnerability assessment in order to better understand the consequences of drought to Montana more specifically.

5. Moving forward with the "Assessment Teleconference"

- Is everyone okay with how it is going?

In general the MSC reported they are satisfied with the Assessment Teleconference and, while there is still clearly room to improve, the process seems to be getting better. One member of the MSC asked for the Governor's Office to create an MOU for them to solidify their relationship with the state. This may be of interest to all of the MSC partners. It was also suggested that a website be created, and perhaps housed at the State Library, where data can be compiled and shared. A question that would be good to address before the next growing season is how to standardize impact reports. There may be an opportunity to streamline this process through the use of surveymonkey or other software available for free on the web. Lisa Coverdale, the NRCS State Conservationist, may be a good person to visit with about doing this. In addition, finding out how to obtain impact information for the media without crossing privacy lines needs to be addressed.